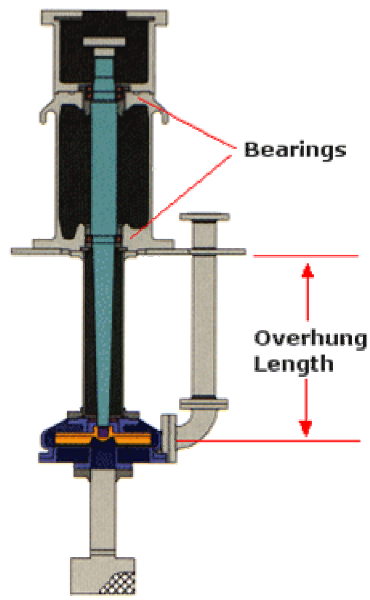
Run Times
LAWRENCE PUMPS INC.
June 2006 *vol.3_iss 6*

Vertical cantilever shaft pumps have been around for about 50 years. Within certain parameters they are unsurpassed at reliably handling abrasive solids and slurries. In this issue we'll cover the basic design concept and application of the cantilever pump.

Dale B. Andrews
Dale B. Andrews – Editor

Design



A cantilever shaft pump generally utilizes rolling element bearings to support an overhung shaft that extends downward into a sump or tank. The bearings are mounted above the maximum liquid level so that they are never exposed to the pumped fluid. Because there are no submerged bearings, the pump handles solids without the need for external flush, or any sealing devices, to keep the pumped fluid out of the support column. Cantilever pumps may also be operated dry, or with loss of prime, without damage.

Cantilever pumps require no seals or packing when used on open sumps. When applied to closed tanks with hazardous materials, the rolling element bearings limit shaft run-out so that mechanical seals may be applied reliably.

With the exception of a few special cases, the shaft and bearing assembly of a cantilever pump is designed so as to operate below 1st lateral critical speed[1]. As the amount of shaft overhang increases, the shaft diameter is increased so as to provide sufficient stiffness to limit deflection and provide rotor stability. The design diameter of the shaft is a function of the length of the shaft overhang, the rotational speed, and the mass of the impeller. Typically, the practical maximum shaft diameter is about eight inches. Above this diameter, conflicts with bearing speed and load ratings start to occur. This diameter equates to a maximum overhung distance of somewhere between six and eight feet for most pumps.

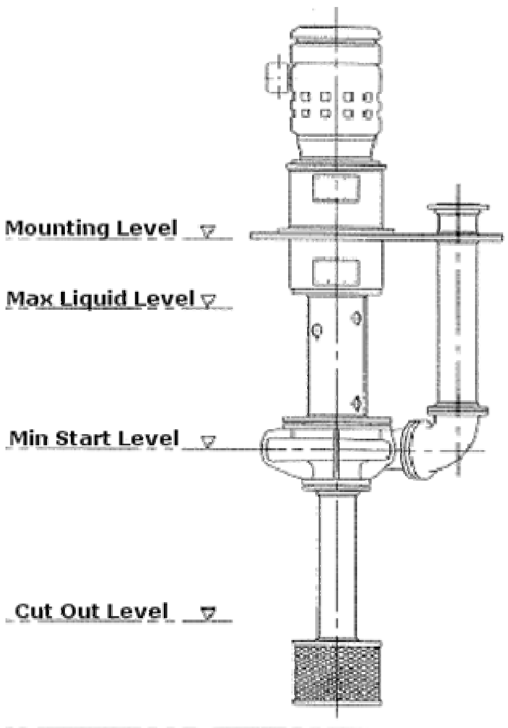
Application

For the most part, cantilever shaft pumps are abrasive solids handling pumps. If the application deals with clean liquids, self-priming pumps, line-shaft (submerged sleeve bearing) pumps or submersible pumps are generally offered as a lower cost alternative. Cantilever shaft pumps are

[1] The lowest speed at which the natural frequency of the shaft is synchronized with the operating speed. Critical speed is characterized by very high vibration levels. Designing below 1st critical speed provides for smooth operations under all 'good practice' operational conditions.

also well suited for very high temperature applications such as molten salt and sodium where temperatures sometimes exceed 750^{o}C (1400^{o}F). The lack of submerged bearings, liberal internal clearances, and non-wetted seals combine to make the cantilever pump a reliable choice.

When abrasive solids are present, cantilever pumps or submersibles are usually the best choice. Although a line-shaft pump may have a lower capital cost, in most cases it is the most expensive pump design, in terms of parts and maintenance, when operated in a slurry environment. Self Priming pumps may be operated to approximately the same sump depths as a cantilever. Although many self-priming pumps are good at handling solids, most designs do not handle abrasive solids well. Wear in a self-primer can quickly deteriorate the pump's ability to prime. Self Priming pumps are also subjected to fluctuating hydraulic loads while priming which can be problematic as pump size, power, and the amount of lift increases. Selections above 50kw (~70 hp) should be reviewed carefully from a bearing and mechanical seal reliability standpoint before making a purchase.



As the overhung length of a cantilever pump increases, shaft diameter quickly starts to have a greater impact on pump cost than the pump capacity (flow rate). Cantilever pumps are the preferred choice over submersibles when the cantilever can be applied in a cost effective manner. This usually means shaft diameters of less than six inches. Although submersibles have become very reliable, the ability to use a standard motor above the liquid level is certainly preferable. This usually limits the application of cantilevers to shallow sumps under 8 to 10 feet in depth with submersibles applied to deeper sumps.

There are a couple of ways to extend the practical operating depth of a cantilever pump without significantly increasing the pump cost. The first method involves suspending the bearing housing beneath the cover plate. This is called shoulder mounting the pump. It will lower the impeller three to five feet without impacting the shaft diameter. It is important to ensure that the lowermost bearing is above the maximum liquid level of sump when considering a shoulder mounted design. The second method involves the addition of a tail-pipe. A cantilever pump requires only that the impeller centerline be submerged at start-up in order to prime. Once primed, the pump can pump down to about 15 feet below the impeller centerline without losing suction[2]. Provided that the sump operation permits the impeller centerline start level, a cantilever pump with a 5 foot overhang and a tail-pipe can provide coverage to a 20 foot sump, or 25 feet with a shoulder mounted design.

In closing, cantilever pumps are an excellent choice for handling abrasive solids if the sump operating levels allow a short overhang and small shaft diameter to be used. The use of a tailpipe greatly extends the effective pumping range of a cantilever with only an incremental increase in pump cost. The simplicity of the cantilever design makes them reliable, easy to operate, and relatively inexpensive to maintain.

[2] The maximum lift is very design and application dependent. On certain designs the maximum lift can be extended to about 20 feet. The trade-offs with increasing the maximum lift capability are with efficiency and axial thrust.

Web http://www.lawrencepumps.com Contact: dandrews@lawrencepumps.com